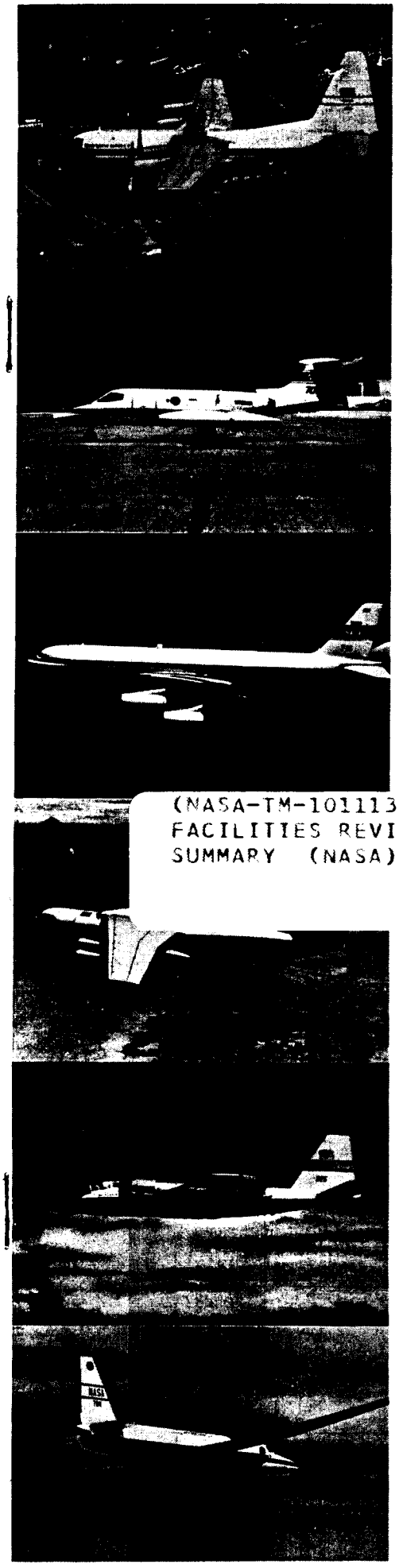

Report of the

NASA AIRBORNE OBSERVATORY FACILITIES

Review Team

I - Executive Summary

February 197

NASA
National Aeronautics and
Space Administration

NASA AIRBORNE OBSERVATORY FACILITIES REVIEW TEAM

February 1978

Daniel J. Shramo, LeRC
6000/Director, Space Systems
and Technology — **Chairman**

Paul F. Holloway, LaRC
6000/Director for Space — **Member**

William S. Logan, Jr., NASA HQS
SA/Manager, Small Expl./S. Rockets/
Airborne/Balloons — **Member**

Bernard T. Nolan, NASA HQS
ERB/Manager, Spacelab/Shuttle
Program Integration Office & AIRP — **Member**

Gary A. Zarlengo, NASA HQS
BR/Office of Deputy Comptroller — **Member**

James J. Ward, LeRC
6210/Chief, System Branch — **Executive Secretary**

CONTENTS

Volume I

EXECUTIVE SUMMARY

Volume II

FINAL REPORT

Volume III

APPENDIXES

NASA AIRBORNE OBSERVATIONAL FACILITIES REVIEW TEAM

CHAIRMAN	- DANIEL J. SHRAMO, LEWIS RESEARCH CENTER DIRECTOR, SPACE SYSTEMS AND TECHNOLOGY
EXEC. SEC.	- JAMES J. WARD, LEWIS RESEARCH CENTER CHIEF, SYSTEMS BRANCH
MEMBER	- PAUL F. HOLLOWAY, LANGLEY RESEARCH CENTER DIRECTOR FOR SPACE
MEMBER	- WILLIAM S. LOGAN, JR., NASA HEADQUARTERS MANAGER, SMALL EXPL./S. ROCKETS/AIRBORNE/ BALLOONS
MEMBER	- BERNARD T. NOLAN, NASA HEADQUARTERS MANAGER, SPACELAB/SHUTTLE PROG. INT. OFFICE & AIRP
MEMBER	- GARY A. ZARLENGO, NASA HEADQUARTERS OFFICE OF DEPUTY CONTROLLER
ADVISOR	- MARTIN A. KNUTSON, AMES RESEARCH CENTER CHIEF, AIRBORNE MISSIONS & APPLICATIONS DIVISION
ADVISOR	- WILLIAM E. RICE, JOHNSON SPACE CENTER ACTG. MGR., EARTH RESOURCES PROGRAM OFFICE
ADVISOR	- ROBERT W. SOMMER, NASA HEADQUARTERS DIRECTOR, NASA AIRCRAFT OFFICE

INTRODUCTION

In the Special Announcement from Dr. A. M. Lovelace, dated September 7, 1977, dealing with NASA Civil Service Manpower Adjustments, a number of Agency issues were enumerated. It was indicated that special study teams would be formed to study, evaluate, and make recommendations concerning these issues. One of the first issues addressed was the Airborne Applications Program, which was subsequently expanded to include all of NASA's aircraft observational platforms. The charter for the observational aircraft review team was formulated. Daniel J. Shramo of the Lewis Research Center was requested to chair the committee. The charter required that all aircraft used as observational platforms be examined and that all programs using these aircraft be reviewed. In FY 77, a total of 24 NASA aircraft were utilized as airborne observational platforms, and eight of the ten centers participated in the program to some degree. The charter of the review team can be summarized into the following four objectives:

1. Define current airborne observational facility capabilities.
2. Establish projected needs.
3. Recommend changes that will improve economy of operation and better match capability to projected needs.
4. Consider desirability of consolidating science and applications airborne facilities.

The team membership was chosen to reflect both a broad background and specific relevant experience such that all facets of the aircraft program could be studied. The team membership and their organizations are shown on page 2.

METHODOLOGY

The methodology adopted for the review process is shown in figure Ex-1. The methodology of information acquisition was chosen to be sure to acquire the information from all four organizational elements that are involved in the aircraft program. The Headquarters program offices (OA and OSS) were requested to pro-

vide a 3-year history and a 3-year projection of flight requirements and program resources and a listing of all aircraft involved.

The primary observational aircraft field centers, ARC and JSC, each were visited. The center reviews included:

- a general program overview
- a review of the management process and the organizational structure of the aircraft program at that center
- a detailed program review of each aircraft at that center
- a 3-year history and a 3-year projection of the program resources and aircraft operation hours
- a tour of the aircraft and support facilities

All centers were contacted and requested to review their aircraft observational program for the review team. The user centers were requested to provide a 3-year program history and a 3-year projection. The history and projections were to include:

- program objectives
- management approach and organizational structure
- program accomplishments
- resources, history and projections in terms of man year equivalents, total dollars, and aircraft experiments

In accomplishing the program review, center visits were also made to JPL and Wallops. Detailed program presentations were made to the committee by LaRC, LeRC, NSTL, and GSFC personnel. Three centers indicated that they were not involved in the aircraft observational program. DFRC indicated no participation, KSC involvement had been very minor and they indicated that their small effort would not continue. MSFC indicated that they had been directed to terminate their minor activity in this area.

Once the information was acquired, the analysis of that data and information first took place in several general team sessions. Structural subtask teams were formed to address three issues:

- future requirements definition and validation
- consolidation
- policy issues

METHODOLOGY

INFORMATION ACQUISITION
- HEADQUARTERS PROGRAM OFFICE OVERVIEW
- HEADQUARTERS AIRCRAFT OFFICE OVERVIEW
- VISIT PRIMARY OBSERVATIONAL AIRCRAFT CENTERS
- DETAILED PROJECT AND TASK REVIEWS BY USER CENTERS

INFORMATION ANALYSIS
- STRUCTURED SUBTASK TEAMS TO ADDRESS
  - FUTURE REQUIREMENTS DEFINITION AND VALIDATION
  - CONSOLIDATION
  - POLICY ISSUES

PROVIDE CONCLUSIONS AND RECOMMENDATIONS
- STATUS REVIEW
- FINAL REPORT

Figure Ex-1.

The analysis of all the data and information was concluded prior to the status report presentation on November 7, 1977, and preliminary conclusions and recommendations had been reached at that time. Completion of the subtask team effort and verification of the detailed data were significantly more difficult and time-consuming than first estimated, but the final results required no substantial change to the preliminary conclusions and recommendations.

OBSERVATIONAL AIRCRAFT COMPLEMENT

The NASA aircraft fleet totals 102 aircraft for all uses, and the fleet logged 22 658 flight hours in FY 1977. A total of 24 NASA aircraft were utilized as observational platforms in FY 1977 and flew a total of 5108 hours. Aircraft that are used as observational platforms fall into two major categories: (1) those aircraft whose principal use is for observational purposes; and (2) those aircraft that are used to support a wide variety of program needs in addition to supporting the observational program. Figure Ex-2 is an overview of the aircraft used to support the observational programs. The observational program utilizes 14 principal aircraft that logged 4315 flight hours. The total cost for the operation of these aircraft was $8714 K including $1241 K of reimbursable funds. The operation required 141 man years of support - 50 civil servants and 91 support service contractors.

The principal aircraft are utilized in support of OSS airborne science programs and the OA Airborne Instrumentation Research Program (AIRP).

The OSS program, carried out totally by ARC, provides the C-141 and a Lear Jet each fitted with a telescope with standard interfaces available to principal investigators. Both aircraft are operated as flying laboratories. OSS also makes use of OA-supported aircraft (the CV-990 and U-2's) as a small but integral part of their program. The program has been historically funded under UPN 352 at a level of $3800 K, $1000 K of which is distributed as grants to principal investigators. The program is supported by 25 civil servants and 25 support service contractors and includes 5 major areas of activity: astrophysics, solar terrestrial investigations, lunar and planetary science, upper atmospheric research and life science. At the present resource level, the program is oversubscribed by a factor of two.

The OA AIRP is funded under UPN 640 and supports a wide variety of investigation areas including weather and climate, earth resources, environmental quality, and ocean dynamics.

GENERAL OBSERVATIONAL AIRCRAFT OVERVIEW

FY 1977

	PRINCIPAL OBSERVATIONAL AIRCRAFT	FIELD CENTER PROGRAM SUPPORT AIRCRAFT	TOTALS
NUMBER OF AIRCRAFT	14	10	24
TOTAL HOURS FLOWN	4315	*793/1959	5108
AIRCRAFT OPERATIONS R&D COST	**8714 K	491 K	**9205 K
AIRCRAFT OPERATIONS MANPOWER	CS - 50 SSC - 91	CS-12 (EST.) SSC-9 (EST.)	CS-62 SSC-100

*$\frac{\text{OBSERVATIONAL FLIGHT HOURS}}{\text{TOTAL FLIGHT HOURS}}$

**INCLUDES 1241 K REIMBURSABLE.

The total of 14 principal aircraft is composed of: 11 aircraft utilized in the OA and OSS observational program, an OV-1 located at Lewis, an E-18 located at NSTL and a KC-135 located at JSC. The KC-135 is used for Zero-G work and is not an observational platform, per se. This aircraft, therefore, was not included in the studies but is included in the data base.

Figure EX-2.

The AIRP is conducted by two principal centers: ARC and JSC, and differs in content, aircraft type, philosophy of operation and organizational structure at each center. At ARC, the AIRP program is highly projectized with some project support supplied by a matrix discipline organization. The OA aircraft operated by ARC out of Moffett Field are a CV-990 medium altitude jet and two high altitude U-2's.

The CV-990 is operated as a flying laboratory much in the same manner as the C-141. The U-2's are one person aircraft operated as general purpose instrument platforms.

In FY 77 the AIRP at JSC utilized the C-130, two WB-57F's (one WB-57 F is totally ERDA reimbused), two helicopters, and a P-3A. The JSC aircraft are operated principally as data acquisition platforms with a fixed sensor complement carried on each flight. The JSC program is also characterized by a major effort in aircraft instrumentation including sensor maintenance, modification and operation, and data processing. JSC aircraft operate out of Ellington Air Force Base.

The AIRP program has changed considerably since its inception and, as indicated previously, in FY 77 supported all applications disciplines and a portion of the OSS science program. It has also been characterized by a decreasing budget, as illustrated in figure Ex-3, which has resulted in changes in the size and content of the program. The OA-directed funding decrease of $3700 K in FY 78 has reduced by half the total historical number of flight hours being supported at ARC, reduced the manpower efforts at JSC and resulted in the elimination of the P-3A and one helicopter from the JSC aircraft complement and a reduction in sensor complement.

OA/OSS OBSERVATIONAL PROGRAM SUMMARY

The following summary illustrates the magnitude of the FY 77 and 78 OA/OSS observational program.

	FY 77			FY 78
	OA	OSS	Totals	Totals
Funding	12 800 K	3800 K	16 600 K	12 900 K*
Manpower:				
CS	121	25	146	108
SSC	256	25	281	215
	377	50	427	323

*Reduction in AIRP program only.

- OA AIRCRAFT INSTRUMENTATION RESEARCH PROGRAM (AIRP)
  - RESOURCES SUMMARY
  - PRINCIPAL AIRCRAFT (FY 77)

JSC	ARC
WB-57F (TWO)*	U-2 (TWO)
NC-130B	CV-990
P-3A	
2 HELICOPTERS	

  - PROGRAM FUNDING (MILLIONS)

	FY 75	FY 76	FY 77	FY 78
ARC	4.2	5.1	5.2	2.9
JSC	10.1	8.0	7.6	6.2
TOTAL	14.3	13.1	12.8	9.1

  - MANPOWER

	FY 75	FY 76	FY 77	FY 78
ARC - CS	19	23	24	24
SSC	52	57	59	51
	71	80	83	75
JSC - CS	141	104	97	59
SSC	314	210	197	139
	455	314	294	198
TOTAL	526	394	377	273

Figure Ex-3.

*ONE WB-57F TOTALLY REIMBURSED BY ERDA.

FIELD CENTER PROGRAM SUPPORT AIRCRAFT UTILIZATION

For the purposes of this report, field center program support aircraft are defined as aircraft stationed at and operated by the field centers to support center Research and Technology programs. These aircraft are used primarily to support OAST space and aero technology and OSS life science programs.

Center program support aircraft are also used in varying degrees to support both science and applications programs. When these aircraft are used for OA and OSS programs, the operations funding comes directly from the discipline offices to support goals. These aircraft are used quite often to support R&T program requirements that are difficult or impractical to support within the general purpose observational program.

A total of ten aircraft were utilized at five centers. These aircraft flew almost 2000 hours with almost 800 hours, or 40 percent of those hours, supporting OA and OSS programs. The cost to support these observational flights was about $500 K of a total slightly under $900 K.

ANTICIPATED NASA OBSERVATIONAL AIRCRAFT NEEDS

The development and validation of future aircraft observation needs proved to be a difficult task to perform with great accuracy. In order to acquire the most reliable projections of future needs, the following procedure was followed:

- Obtained 3-year history from 4 sources
  - OA/OSS program offices
  - Lead Centers
  - User Centers
  - Headquarters aircraft office
- Obtained 3-year requirement projections from 3 sources
  - OA/OSS program offices
  - Lead Centers
  - User Centers
- Examined use history and projected requirements
- Examined OA and OSS procedures for experiment flight acceptance
- Applied historical program factors, where necessary, to arrive at anticipated needs

Based upon the above analysis, an estimate of future requirements for OSS, OA, and field center support aircraft in support of observational needs was made.

OSS Program

The OSS program is a level of effort activity and the program is oversubscribed by at least a factor of two. The current level of effort utilizes significantly less than the maximum capability of the two observational aircraft (C-141 and Lear Jet). It also appears that good science programs that could be supported by the aircraft are not being accomplished due to funding limitations. The utilization of these aircraft could be easily increased by 50 to 100 percent if the resources were made available.

OA Program

Currently, approximately 50 percent of the flight requests are being implemented. Approximately 20 percent of the flight requests are rejected due to poor justification, unclear project plans, or insufficient project funding. The additional 20 to 30 percent reductions are due to combining investigations for fewer flights or to flight reductions due to limited aircraft funding.

In the medium altitude area, the C-130 is oversubscribed while the CV-990 is underutilized due to funding limitations. These aircraft appear to be able to satisfy medium altitude observational needs through the late 1980's if resources are provided and if policy positions stabilize aircraft availability and aircraft user charges.

At least the current level of both high altitude flight activity (historically, 1200 to 1400 hr/yr including hours for ERDA) and performance capabilities will be required for the foreseeable future. The existing fleet (2 U-2's, 1 NASA WB-57F, 1 ERDA WB-57F) can fly up to a total of about 2000 hours per year. It should be noted that the WB-57F's are no longer major operational aircraft. They are currently used only by NASA with Air Force high altitude observational requirements being met with other aircraft.

Field Center Support Aircraft

There was no evidence available from users or from the supporting program offices that any significant change in the flight hour requirements for these aircraft is anticipated.

There was also no indication that the use pattern will change in the near future. The field centers respond to programmatic needs by the most effective method available. The nature of the programs supported by the field center aircraft require flexibility in flight schedules that would be difficult or impossible to support with the principal operational aircraft.

CONSOLIDATION

In considering the desirability of consolidation, two approaches were examined: geographical consolidation and fleet-type consolidation. Consolidation needs to be considered to determine if NASA observational aircraft needs can be met with an economy of resources. In considering geographical consolidation, moving all principal aircraft to either JSC or ARC was examined as an example of potential operational economies.

The estimated recurring cost for consolidated operation is roughly equal at either Center. The difference in nonrecurring costs are minimal, with the exception of the cost to relocate the JSC AIRP data support function at ARC. The total nonrecurring cost varies from $1300 K for consolidation at JSC to $2100 K for consolidation at ARC. Based on this study, the savings in operations cost that could be realized by consolidation is potentially in the order of $2000 K - $2500 K, therefore, only a 1-year payback time would be required if these savings are truly attainable.

The data indicate that the cost to fly the airframes will not vary much for a given level of activity regardless of where the aircraft are located.

The largest potential area in which NASA could realize economies of operation lies in the nonaircraft supporting functions: sensor and data support. However, these supporting functions are a part of each center's R&D technical base and, to a degree, are charges applied to the aircraft program as well as to other R&D programs by an allocation process. As such, this effort may not be easily terminated at, or transferred from, the respective centers without impacting the allocation to other on-going or planned for R&D activities. Reducing the aircraft's data or sensor processing support at one center may just shift all or part of that same burden over to other R&D programs. In short, significant savings to NASA may not be attainable.

In addition to fiscal aspects of consolidation, intangible and/or unquantifiable factors also must be considered since they may have significant programmatic impact. Following is a partial list of such factors. A more complete list is found in the body of the report.

- Morale at centers due to impact of any transfer of civil service personnel or adjustments to center manpower ceilings.
- Impact on roles and missions assignments of respective centers.
- Down time and dis-economies occurring while consolidation actually takes place.

Since the potential savings due to geographical consolidation may not be realized and the intangible factors may have significant negative programmatic effects, geographical consolidation is not recommended at this time.

An alternate to geographical consolidation is fleet consolidation by type and number of aircraft. Since, as indicated in OA Program Needs section, the high altitude fleet is underutilized, the option of fleet consolidation should be considered. It should be noted that the current fleet provides a mix of large payloads, altitude possibilities and ranges for observational tasks. For example, the WB-57F cannot fly as high as the U-2, while the U-2 cannot handle large payloads. Both aircraft are presently needed because of their unique performance capabilities.

In the development of consolidation scenarios, performance requirements should be carefully evaluated. Given the long term need, airframe update should also be considered. Current USAF plans to acquire the ER-2, an aircraft with considerably expanded performance over both the U-2 and the WB-57F, offer NASA an opportunity to update airframes, meet current performance capabilities, and, in fact, offer expanded performance capabilities with fewer aircraft. Additional options, costs and implementation scenarios should also be considered.

However, any commitment to upgrading must be substantiated by firm programmatic needs and the evaluation of the value of the extended capability afforded by updated aircraft.

PROGRAMMATIC ISSUES

During the conduct of the study, it became apparent that several issues needed to be addressed. Principal among these are:

- The need for a programmatically stable observational aircraft support capability to meet NASA's and national research and technology development needs.
- All observation aircraft support elements require policy positions
  - Principal general purpose aircraft (e.g., U-2, WB-57F, C-130, and CV-990)
  - Field center program support aircraft
- The observational aircraft are a national capability used broadly
  - Policies governing interagency and industrial cooperative and reimbursable efforts should be reviewed.
  - Target-of-opportunity/disaster/good neighbor policies with simple procedures need to be established and applied uniformly.
- Senior Headquarters oversight of principal aircraft activity is required.

- The need for a mechanism to screen requirements for all elements of the aircraft program without degrading the flexibility of the center managed aircraft.
- The requirement to focus feedback from observational aircraft users to provide a separable, visible source for periodic assessment of the effectiveness of aircraft utilization.

SUMMARY OF PRINCIPAL OBSERVATIONS, FINDINGS, AND RECOMMENDATIONS

- The observational aircraft fleet has decreased in recent years. The current fleet capability appears to be able to meet the observational needs, however, resource constraints now limit utilization of the full capability.
- A stable, adequately-funded aircraft observation capability is needed to meet NASA program needs for the foreseeable future.
- The study of projected needs indicates:
  - At least the current level of capability of medium altitude observational aircraft is required for the next 3 to 5 years; the level of capability required during the Shuttle operational era will depend upon Shuttle experience and NASA programmatic direction thrusts. These needs may increase or decrease.
  - High altitude observational aircraft capability will be required indefinitely for in-situ measurements and sensor test needs not impacted by the Shuttle. The level of capability required to support other high altitude needs during the Shuttle era will be determined by Shuttle experiences and NASA programmatic goals.
- Geographic consolidation does not appear to be prudent at this time.
- Fleet consolidation of the high altitude capability should be considered now. Given the continuing need for an airborne capability, airframe replacement plans should be developed. Current USAF plans to acquire the ER-2, an aircraft with considerably expanded performance over the current high altitude aircraft, offer NASA an opportunity to update the airframes, meet current performance capabilities, and offer expanded performance capabilities with fewer aircraft. In 3 to 5 years, replacement of the medium altitude airframes should be evaluated.